

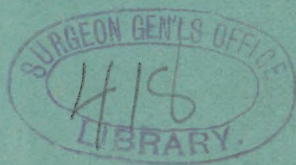
Curtis (B. F.)

*The Treatment of Arterio-venous Aneurism,
with Two Cases Treated by Extirpation.*

BY

B. FARQUHAR CURTIS, M.D.,

ATTENDING SURGEON TO ST. LUKE'S HOSPITAL AND TO THE NEW YORK
CANCER HOSPITAL.



FROM
THE AMERICAN JOURNAL OF THE MEDICAL SCIENCES,
FEBRUARY, 1891.

THE TREATMENT OF ARTERIO-VEINUS ANEURISM, WITH TWO CASES TREATED BY EXTIRPATION.¹

BY B. FARQUHAR CURTIS, M.D.,

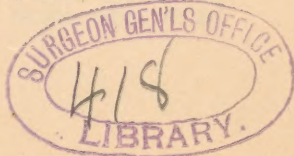
ATTENDING SURGEON TO ST. LUKE'S HOSPITAL AND TO THE NEW YORK CANCER HOSPITAL.

CASE I.—John S., twenty-eight years of age, single, a factory-hand, born in the United States, was admitted to my service at St. Luke's Hospital, December 20, 1889. The patient's family history was good, and he had always enjoyed good health. Four years before he had contracted syphilis, but it had never affected him seriously. Thirteen years before, he was shot in the right leg with a pistol ball of .22 calibre, entering (from the left side) near Hunter's canal, and remaining in the tissues. The leg swelled at once after the injury, and he could not walk for two months, but he never felt any pain. One year later he first noticed a pulsation in the popliteal space, and thinks that he discovered a thrill at the same time, but the limb occasioned him no trouble, and he worked and walked as usual. One year ago the veins in the leg became greatly swollen, œdema of the leg and foot appeared, and ulcers formed on the leg, which caused him great pain. His condition gradually grew worse, and last week the pain kept him awake at night.

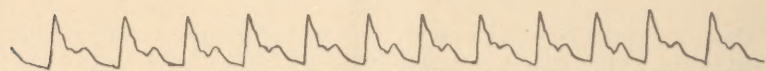
Examination: The right lower extremity is much increased in size, and six inches above the patella it measures $19\frac{1}{2}$ inches in circumference as against $15\frac{1}{2}$ inches in the left; and below the tuberosity of the tibia the right leg measures $15\frac{1}{4}$ inches in circumference, while the left measures only $11\frac{1}{2}$ inches. The veins of the entire extremity are distended and very numerous, and strong pulsation can be seen in the superficial veins about the knee and over the thigh—except on its inner and upper surface. Below the knee there is no pulsation in the veins. The venous distention and pulsation are most marked on the outer side of the thigh, even as high as the great trochanter. When the soft parts of the thigh are pressed between the hands a strong expansive pulsation is felt. The skin of the leg is of a dark bronze color, thickened and scaly, and there is an ulcer one-half of an inch in diameter, and of chronic appearance, situated on each side of the leg near its middle. There is a faint scar at the point where the patient says that the bullet entered—near Hunter's canal.

There is a general expansive pulsation visible in the popliteal space, and the skin here is œdematous, but no well-defined tumor can be made out. A very strong pulsation can be seen and felt along the femoral vessels, and extending over Poupart's ligament, where a pulsating tumor can be felt over the external iliac vessels, about the size of a hen's egg. It is impossible to distinguish between the pulsation of the artery and that of the vein. There is a very strong thrill to be felt over the pop-

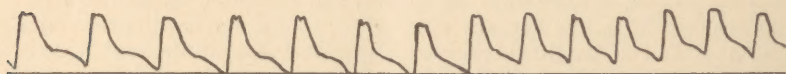
¹ Read before the New York Clinical Society, April 28, 1890; second case reported December 26, 1890.



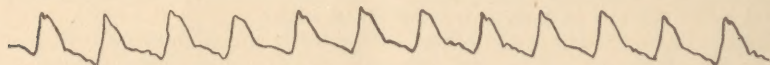
liteal space, and this thrill is conducted upward along the femoral vessels into the tumor above Poupart's ligament, and it is also to be felt in the superficial veins of the thigh, but not in those below the knee. This thrill is continuous, but its intensity varies with the arterial pulse, being most marked at the apex of the pulse-wave. Corresponding to the thrill a loud, rough murmur can be heard over the same area by bringing the ear into contact with the leg, but not at a distance; the murmur is also continuous, its intensity varying with the pulse-wave,



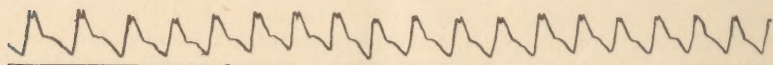
John S. Right radial; pressure $3\frac{1}{4}$ ounces. January 18, 1890.



Over tumor in popliteal space; pressure $2\frac{1}{2}$ ounces.



Over tumor on inner aspect of thigh; pressure 3 ounces.



Femoral, 6 inches below Poupart's ligament; pressure $3\frac{1}{4}$ ounces.

and has all the characteristics of the murmur heard in arterio-venous aneurism. One of the surgeons who examined the patient thought that he could detect pulsation and thrill in the anterior tibial artery, and perhaps on that occasion some unusually favorable position of the limb rendered this possible, but none of the other surgeons were able to recognize any peripheral pulse in spite of frequent and careful examination. Pressure upon the femoral artery below Poupart's ligament, or at the apex of Scarpa's triangle, stopped the pulsation and thrill in the popliteal tumor, and at the same time the tumor above Poupart's ligament grew smaller and lost its pulsation. Very forcible pressure was necessary to control the pulsation of the vessels in any part of their course. The strongest pulsation, thrill, and murmur were observed to be situated on the outer side of the popliteal space—not over Hunter's canal.

The patient was kept in bed for a fortnight, during which the extremity grew much smaller and the ulcers healed. A distinct tumor could then be recognized in the upper and inner part of the popliteal space, toward Hunter's canal, about the size of a hen's egg. The heart-sounds were normal and the apex-beat lay three and a half inches to the left of the median line and external to the nipple.

Operation, January 20, 1890. The patient was etherized and Esmarch's bandage was applied to the thigh, after a rubber bandage had been fastened around the leg below the knee (to form a reservoir of blood to facilitate dissection), and leaving also the blood in the sac and its neighborhood. All of the very numerous vessels crossing the incision were divided between double ligatures. Drawing the nerve to the inner side, we reached the tumor, which filled the entire popliteal space, and was found to consist of the popliteal vein, immensely distended, and forming a sac three and a half inches long and one and a quarter inches in diameter, the distended part passing quite suddenly at each end into the vein of normal size. The sac was not adherent anywhere, and it was easily enucleated from the surrounding tissues, there being but one small branch given off from the vein (on its anterior aspect) in the whole length of the distended portion, until the upper angle of the popliteal space was reached. At this point the communication between the artery and vein was found, and such a sheaf of branches was given off from the latter that it was necessary to enlarge the incision upward for three inches (a total of seven inches) before the true relations of the parts could be ascertained. It was finally made out that the artery and vein were connected by a short passage, about a quarter of an inch long and of about the same diameter, with walls of the thickness of the arterial walls, about half an inch below the ring in the adductors, and that, directly opposite the opening in the vein, six or seven branches sprang from the latter by a common trunk, the combined area of their openings being fully equal to the calibre of the vein itself. This short venous axis was directed outward, and this fact explained at once why the pulsation and thrill had always been so strong under the outer hamstring. Besides these vessels, there were others given off from the external and anterior surfaces of the vein, and a large vessel arose from the short channel of communication between the artery and vein, passing downward and appearing to be one of the muscular arterial branches. The dissection was made very difficult by the tangled mass of veins, but finally they were all secured. The artery was ligated above and below the point of communication, and about half an inch of it was cut away, including this point. A small branch of the artery just below also required ligation. The vein was secured above and below the dilated part, and the latter excised. The Esmarch constrictor was removed, and so thoroughly had even the smaller vessels been secured, that only two or three more ligatures were required. The artery was of normal size, and its walls of normal thickness, so far as it was exposed in the wound, while the veins were all enlarged and their walls much thicker than natural. A drainage-tube was inserted and the wound closed with catgut sutures. When the dressing was completed, a very faint capillary circulation was found to be present in the toes, as was shown by the return of color when the blood was pressed out of them. The circulation improved daily, and became natural by

the fourth day, and on that day the sensation in the foot, which had previously been rather blunted, appeared to be normal.

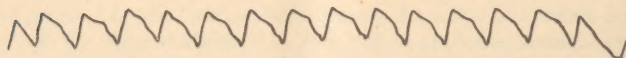
About two weeks after the operation, when the wound had healed, and after the patient had been sitting up for a day or so, about a drachm of pus was discharged from the upper angle of the wound, apparently coming from a considerable depth.



John S. Femoral, 5 inches below Poupart's ligament. February 25, 1890.

February 26th, the patient was discharged. The right thigh then measured 18 inches in circumference at the groin, 15 inches at the junction of the middle and lower thirds, and $14\frac{5}{8}$ inches above the patella. The right leg measured $12\frac{1}{2}$ inches in circumference below the knee, and at the junction of the upper and middle thirds $11\frac{3}{4}$ inches. There was no pulsation to be felt in the popliteal space. A large artery courses down upon and external to the outer hamstring, very superficially, and the anastomotica magna can also be felt quite distinctly. Pulsation in the femoral and external iliac arteries is more forcible than natural, but less so than before the operation. There is still something of a tumor above Poupart's ligament, but it is much smaller and does not pulsate so forcibly. (In the following May, the condition of affairs was about the same.)

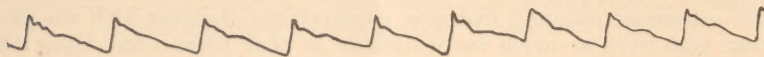
CASE II.—William McC., twenty-four years of age, single, born in New Orleans, a laborer by occupation, was admitted to St. Luke's Hospital, suffering from a crush of three fingers of his left hand, October 30, 1890. He has always enjoyed good health, and denies syphilis. About nine years ago, he was shot in the right knee, with a pistol, the ball of which entered on the inner side and emerged from the outer. A very large



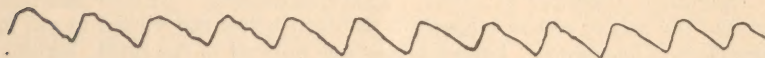
Wm. McC. Right femoral at Poupart's ligament. November 3, 1890.

pulsating tumor appeared at the point of injury (as large as the head of a young child, according to the patient's account), and he felt a strong thrill which extended up into his body. He had no surgical treatment, but kept his bed until the wound healed. The tumor gradually diminished in size, and in a few weeks he was working as usual. Five years ago, he injured the skin over the right tibia, and since that time has had a succession of ulcers, which, although of small size, were very painful. He has a feeling of numbness and coldness in the right foot, and that limb is more easily fatigued than the other.

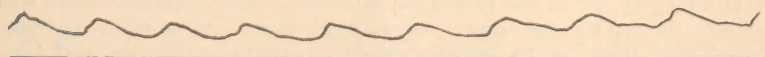
Examination of the limb shows an ovoid tumor between the internal condyle and the hamstring of that side, projecting one inch above the level of the limb, and measuring five inches vertically and two and a half transversely. This tumor pulsates strongly and expansively, and the skin over it is traversed with distended veins, which, however, do not pulsate. There is also a diffuse pulsating swelling in the popliteal space, more prominent externally, where the hamstring tendons appear to be flattened out over it. At the most prominent part of the first tumor, just above and behind the epicondyle, is a scar, where, the patient says, the ball entered; and in a corresponding position on the outer side of the knee is a slightly larger scar, which, he says, is the wound of exit. An enlarged artery is felt passing down along the anterior border of the first tumor and on the inner side of the patella, and along the outer



Left radial; 3 ounces. November 26, 1890.



Over tumor, outer part of popliteal space; 3 ounces.



From pulsating vein near saphenous opening.

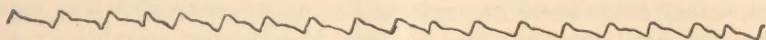
border of that bone is a similar vessel. The anterior and posterior tibial arteries cannot be felt. The veins of the leg and thigh are distended, but there is no pulsation in them, except in one large vein, which appears under the skin at the back of the middle of the thigh and turns around its inner border to empty into the deeper veins at the saphenous opening, and the pulsation in this vein is increased by pressure upon it just before it reaches that point, showing that it receives the pulsation distally. Over the tumor can be felt a very strong arterio-venous thrill, most distinct near the wound of exit, and the same thrill is felt in the pulsating vein just described, and at the saphenous opening, where it is nearly as strong as at the wound of exit. The thrill is not conducted into the tissues surrounding the aneurism, but is felt along the great vessels of the thigh, although not so distinct as at the saphenous opening. A very loud and rough arterio-venous murmur is heard over the aneurism and wherever the thrill can be felt, and it is also transmitted through the tissues of the entire limb, being heard with the stethoscope in the sole of the foot. Pressure upon the femoral, anywhere from Poupart's liga-

ment to Hunter's canal, will stop the pulsation, thrill, and murmur, and the artery can be compressed without the use of very great force. The right leg does not differ from the left in size, condition of skin, or hair, but it bears a very tender ulcer, about an inch and a half in diameter, in the midst of a scarred and pigmented area. There is no œdema, and the veins are not greatly distended.

The patient was kept in bed for some time, until the ulcer had practically healed, and he had recovered from the injury to his hand, and during this time the pulsation, thrill, and murmur diminished very noticeably. December 8th, it was noticed that there was no thrill in the tumor which projected between the condyle and hamstring on the inner side of the knee, and that it had also disappeared from the dilated vein described as emptying into the saphenous opening. Very slight pulsation was occasionally observed in a vein in front of the internal malleolus. No thrill could be detected in the vessels immediately above Poupart's ligament, in spite of the distinct thrill and loud murmur at the saphenous opening, and this circumstance, together with the fact that both were so much more distinct at that point than along the great vessels in the thigh, make it probable that they were intensified there by the cross current from the superficial distended vein, and were not conducted along the femoral vessels. The murmur was also less marked over the internal part of the tumor than in the popliteal portion.

Operation, December 11, 1890. Ether anæsthesia. Rubber bandage around the calf to secure a reservoir of blood below the wound to aid in dissection if necessary. Esmarch bandage applied to the thigh, leaving the sac free from compression. An incision seven or eight inches long was made over the popliteal space in the median line of the limb, extending up to the middle of the thigh. When the fascia had been divided, the entire popliteal space was found filled with the sac of the aneurism, and this was separated from the surrounding parts with a little difficulty, for it was somewhat adherent. The popliteal nerve was not seen during the operation. Some large vessels communicating with the sac were found on its outer aspect, lying quite superficially, and were divided between double ligatures. The lower end of the sac was then turned out of its bed and found to be divided into three lobes by deep grooves, the central lobe lying between the heads of the gastrocnemii. The internal lobe lay to the inner side and in front of the inner hamstring, which had formed the sulcus between it and the middle lobe. The external lobe lay under the outer hamstring, which was expanded over it, and was divided from the middle lobe by a groove formed partly by the tendons, partly by the vessels as they twisted around the sac. The entire sac was then readily dissected out, and it was found that the vessels already tied off were the popliteal artery and vein, which lay on the outer side of the sac, passing spirally around it, from their exit from Hunter's canal above and in front of the sac, to the middle of the popliteal space below and behind it. The remains of the vessels were sought in the wound, and about an inch of each was removed in the neighborhood of their communication with the sac. The vessels lay side by side at their point of communication with the sac, and probably opened into it on their internal and anterior aspect by a common orifice. The specimen was injured at this point in the dissection, and it was impossible to ascertain their exact relationship. There were no other vessels

opening into the sac. All vessels had been tied in the wound as they were divided, and only a few points required ligature after the removal of the Esmarch. The wound was closed by a continuous catgut suture, a gap being left in the middle of the popliteal space for drainage, and a small tent of iodoform-gauze was inserted into it. A pad of iodoform-gauze was placed next the wound and bichloride dressings applied. The entire foot and limb were wrapped in cotton. Even immediately after the operation was concluded, the circulation in the toes was fairly good, the blood returning quite promptly when pressed out by the finger, and the next day it was normal. The operation lasted two and one-half hours.



Femoral in Scarpa's triangle; 4 ounces. December 31, 1890.

The sac resembled the inverted human heart in shape, and measured when distended three and one-half inches from base to apex, three inches across its broadest part, and two and one-half inches in thickness from before backward. Its walls were formed of laminated cellular tissue and its shape also showed its origin as a diffuse (traumatic) varicose aneurism. The sac was partly filled with firm clot on the side opposite to its communication with the vessels. The vein was of normal size, the artery being also normal above, but contracted to about two-thirds of its natural diameter immediately below the point of communication with the sac.

The wound healed by primary union, except in its central portion, where the displaced tendon of the semi-tendinosus made some pressure. The patient feels well, and his ulcer has healed, but it is too early to say whether it is permanently cured.

William Hunter and Guattani first recognized the aneurisms connected with both arteries and veins, and explained their pathology, but we owe the name arterio-venous aneurism to Virchow. The division of these aneurisms into varicose aneurism (a sac connected both with an artery and with a vein) and aneurismal varix (in which a direct passage exists between the two, without the formation of a sac) originated with Scarpa. These subdivisions answer for the classification of most cases, but it is necessary to recognize an intermediate form in which the artery communicates directly with the vein, and there is no separate sac, but in which the vein is so greatly distended at the point of communication as to form a sac—a variety of which my first case is an example, and which has been especially described by the French authors. Although these aneurisms belong anatomically to the class of aneurismal varix, they are clinically similar to varicose aneurisms, having the same tendency to growth and liability to rupture.

When a communication has been established between an artery and a vein, the walls of both vessels undergo certain changes, and their

calibre alters, and these changes are of great importance in considering the safety of applying a ligature to the artery, and to the vein as well. The older writers undoubtedly exaggerated the extent and frequency of these changes. The veins, as a rule, are distended, although not always, and their walls become thickened. According to the majority of authors, the calibre of the artery above the site of the communication becomes enlarged, but Bramann expressly states that the artery generally remains normal unless endarteritis is present. As no one else appears to have analyzed the reports of so large a number of cases as this writer, I have carefully sought the original records of his cases as far as they were accessible, accepting his own summary when they were not, and have analyzed thus 81 cases in which an operation or an autopsy allowed the vessels to be examined. The condition of the artery is noted in 33 cases, in 19 of which the calibre of the vessel was enlarged above the communication with the vein, and in four others both above and below. In 10 cases it is expressly stated that the vessel was not enlarged above, in 5 of which it is also said to have been healthy below. In 7 cases, moreover, in which the artery was enlarged centrally, it was not enlarged peripherally. The presence of endarteritis is mentioned in only two of the cases. In 3 cases it is stated that the artery was contracted beyond the aneurism. It would appear from this showing that Bramann is incorrect in his assertion, and that the commonly-accepted opinion that the artery is frequently dilated above the aneurism is much nearer the truth. On the other hand, in reading the reports of recent operations, I have been much struck by the fact that the artery was found to be normal in so many cases, as it certainly was in my first case. In my second the artery was normal above, but contracted below. Perhaps this difference is due to the fact that the operation is now performed before the changes have progressed as far as they were formerly allowed to go. The cause of this enlargement of the artery is unknown, and as we do not even know as yet whether the blood-pressure at this point is increased or diminished, we must wait for more knowledge before a satisfactory theory can be framed.

As to the condition of the artery beyond the aneurism, the figures already given show that it is generally normal, but that it may sometimes be contracted, even when it is dilated above. But there are four exceptional cases in which there was a general enlargement of the peripheral artery and its branches. One of these we can explain by general atheroma, as the aneurism was originally arterial, becoming varicose by perforation of a vein. In two other cases the temporal artery was involved, and, although we cannot assume the presence of atheroma, for one patient was only eighteen years of age, the liability of this vessel to form cirroid aneurisms may account for the change. The fourth case was Dupuytren's, occurring in the thigh of a young man

who was wounded six months previously, at the site of the aneurism, in Hunter's canal—and it is totally inexplicable. The opinion that the artery is usually contracted below, appears to have been formed from the fact that the peripheral pulse was weaker than normal, but this is an unreliable sign, for the pressure of the tumor might cause a diminution of the pulse-wave, even when the artery retained its normal calibre. The mere loss of blood by leakage into the vein may cause a weakness of the peripheral pulse, as is very beautifully proven by the case of Müller (*Archiv. f. klin. Chir.*, xv., 1873), in which a soldier was wounded in the left arm, near the axilla, by a rifle-ball, and an aneurismal varix formed without a tumor, but with great distention of the superficial veins. Six months after the injury, the radial pulse could not be felt unless pressure was made so as to prevent the flow of blood from the artery into the vein, when, with the cessation of pulsation in the veins, the radial pulse became distinct, only to disappear again on removal of the pressure. Eighteen months later the condition remained the same, showing that an artery can remain of normal calibre for years, even if its usual blood-supply is very much reduced, and also that absence of the peripheral pulse does not prove diminution of the calibre of the vessel at that point.

As the artery dilates, its walls are apt to grow thin, and some would ascribe the thinning of the arterial wall to the diminished blood-pressure, but it is by no means certain that the arterial pressure is less than normal, and in some cases it is apparently greater—certainly an increased force of pulsation of the artery is a very frequent symptom. The sphygmographic evidence, which might throw light upon this point, is not yet extensive, but so far as it goes it favors the idea of an increased blood-pressure in the artery. Dr. Keen has published a tracing from the radial artery in a case of arterio-venous aneurism of the flexure of the elbow, before and after the operation, and it shows a much more forcible beat on the diseased side before the operation, the difference between the two sides disappearing almost entirely after the operation. Richet also found a similar difference between the two radials in a case of arterio-venous aneurism of the bend of the elbow, in which the tracing was made by the celebrated Marey himself—but unfortunately no tracing was made after the operation. These cases, then, indicate a rise in blood-pressure in the artery beyond the aneurism, and imply that the obstruction to venous return of the blood may project itself into the artery through the capillary system even although the latter does not show any signs of it. The evidence of these cases is not weakened by such cases as that of Müller already quoted, in which the radial pulse was lost on the diseased side, for the seeming contradiction can undoubtedly be explained by differences in the size or position of the communication between the vessels, or in some other mechanical conditions.

There is also evidence of increased pressure in the artery *above* the aneurism in some cases. Ebenau's tracings in Czerny's case (*Berlin. klin. Wochenschr.*, 1883, 19) of a small aneurism in Hunter's canal, taken (it was supposed) over the femoral vein, probably give a combination curve of both artery and vein. It is a very remarkable curve, with a broad apex indicating a high blood-pressure. In my cases, Dr. Joseph A. Blake and Dr. L. F. Warner, house-surgeons of the hospital, made tracings with Dudgeon's sphygmograph from the popliteal tumor itself, from a dilated vein, and from the femoral vessels; it was impossible to distinguish between the artery and the vein. As no peripheral pulse could be felt, no tracings could be made beyond the aneurisms. All the tracings are very similar, showing an arterial curve of high tension with a broad apex—in the first case made up of two sharp points. In tracings made after the operation, these peculiarities are absent. One might be tempted to explain the double apex as due to pulsation in the vein immediately following that in the artery, but as the same characteristic is found in the tracing made over the tumor, I think we must attribute it to a vibration of the lever of the instrument on an unusually broad apex, due perhaps to the very forcible pulsation of the vessels.



Case of Dr. R. F. Weir. Femoral above the aneurism.

Dr. Robert F. Weir has kindly given me permission to show a tracing made in an unpublished case of his by Dr. Ellsworth Elliot, Jr., also with Dudgeon's instrument. The aneurism was a small sac connected with the anastomotica magna artery and vein, and the tracing was made over the femoral vessels above the tumor.¹ The curve is similar to that in my cases. It is interesting to compare the curve over the sac in my cases with that obtained by Bramann in v. Bergmann's case of axillary aneurismal varix, the latter being a purely arterial curve. On the whole, although the tracings indicate increased tension in the artery above the aneurism, they differ so much that we need more material before any definite conclusions can be drawn from them.

The symptoms and diagnosis of arterio-venous aneurism require but slight notice here. The signs which are spoken of by most authors as invariably present, and which are certainly pathognomonic when they are found, are the thrill and murmur. But the thrill is sometimes

¹ A lad of fourteen years, who had wounded himself with a sharp iron rod four weeks before. Extirpation. Cure. Sac nearly one inch in diameter.

absent, and the murmur may be of the ordinary arterial bruit type, so that such careful observers as Czerny and Annandale thought that they had to deal with arterial aneurisms until the true nature of their cases became evident during the operation. No particular cause was discovered which would account for the absence of these important symptoms in their cases. Perhaps the sphygmograph may help us in the future. If it were proposed to apply the Hunterian ligature in such a case, on the supposition that the aneurism was of the arterial form, the mistake would be a very serious one, for this method of treatment is a very dangerous one in arterio-venous aneurism.

TREATMENT.—Arterio-venous aneurisms have proven peculiarly recalcitrant to the simpler means of treatment, and, owing to their relatively good prognosis, surgeons have dreaded to undertake the more serious operations by which alone they could be cured. But if the records of these operations are examined, it becomes evident that the principal dangers incurred are such as have been greatly diminished by the advances of modern surgery. The older surgeons were certainly justified in thinking that the evils of this condition were seldom sufficient to justify exposing the patient to the dangers of primary and secondary hemorrhage, gangrene and pyæmia, which operations at that time implied; but the Esmarch bandage and the artery-clamp render hemorrhage easily controllable during the operation, and with the improvement of the materials for ligatures and the freedom from septic complications in the after-course of the wounds, ligature of large veins without bad consequences is a matter of daily occurrence, and secondary hemorrhage and sepsis have become rarities, so that the views of modern times have changed very considerably, and operations have become more frequent.

Compression.—Compression has failed, as a rule, in these aneurisms, except in cases which were treated very early and in which superficial vessels were involved. Pressure has generally succeeded only when applied so as to occlude the opening between the artery and vein while it was also exerted on the artery above. In some cases the aneurism was converted into the arterial form and then completely cured by the Hunterian ligature. Among 26 cases of reported cures by compression collected by Bramann, 20 were in the brachial, 2 carotid, and 3 femoral. (Note that his lists give a total of 63 cases of brachial arterio-venous aneurisms, and 46 femoral and popliteal cases.)

The methods of galvanism and of injection of coagulating substances into the sac are totally inadmissible in these cases, although there have been a few instances of cure by these means, for the danger of embolism is very great on account of the direct communication between the sac and the vein, and I am surprised to find that so good an authority as Holmes still admits them to a place among methods worthy of trial.

Hunterian ligature.—The results of the single ligature applied above the lesion,¹ generally after the Hunterian method, for this form of aneurism, have been very bad. Van Buren collected 24 cases, and adding to them the cases in Bramann's list, which were so treated, and a few from other sources, I find the following results:

CASES OF HUNTERIAN LIGATURE FOR ARTERIO-VEINUS ANEURISM.

VESSEL.	Gangrene occurred.	RECOVERED.			Died.	Total cases.
		Cured.	Improved.	Unimproved.		
Common carotid	...	...	2	1	4	7
Subclavian	...	...	...	...	2	2
Brachial	2	4	...	9	6	19
Common iliac	1	...	...	...	2	2
Internal iliac (gluteal) . .	...	1	...	...	...	1
External iliac	4	...	...	2	5	7
Common femoral	2	1 (amputated)		...	1	2
Femoral superficial	2	1	...	6	3	10
Anterior tibial	...	1	...	...	...	1
Totals	11	8	2	18	23	51

According to this table, we have only 8 cures in 51 cases, including 1 case saved by amputation after gangrene set in. We will not consider the mortality as shown by this table, for in order to collect a sufficient number of cases it was necessary to use very old ones, and the most frequent causes of death were sepsis and secondary hemorrhage, and will only note that the operation failed to cure one-third of the cases. But I wish to draw attention to the great frequency of gangrene as compared with the same operation performed for arterial aneurism. That both cases of ligature of the common femoral caused gangrene is not surprising, but note that there were 2 cases of gangrene in 19 ligatures of the brachial, 2 in 10 of the superficial femoral, and 4 in 7 of the external iliac. Gangrene after ligature of the brachial is an exceedingly rare accident, and in 77 cases of ligature of the femoral for popliteal aneurism Holmes (*System of Surgery*) found only 3 cases of gangrene, while Norris (*AMERICAN JOURNAL OF THE MEDICAL SCIENCES*, 1847, xiii. p. 13) found 11 cases of gangrene in 95 of ligature of the external iliac. These facts have completely condemned the operation for use in the extremities, and the high mortality of the operations in the neck condemns it there also. The greatest care should therefore be taken to exclude the possible existence of an arterio-venous aneurism, when it

¹ Of course the single distal ligature has never been applied to these aneurisms.

is proposed to perform the Hunterian operation in any case of aneurism of the extremities. The explanation for the frequent occurrence of gangrene in these cases given by Stromeyer (*Handbuch der Chirurgie*, 1844) is undoubtedly the correct one, namely, that when the collateral circulation is established and the blood finds its way past the ligature into the artery beyond, it flows directly into the vein through the communication with that vessel, instead of passing on to the peripheral circulation. Therefore, an accidental inclusion of the vein with the artery in the ligature would actually be a favorable occurrence.

Double ligature of the artery.—The double ligature of the artery above and below the point of communication, treating the latter as a simple wound of the vessel, and without attacking the sac itself, has given fairly good results. Of 15 cases we find 9 cured, 2 relapsed, 1 recovered after amputation for gangrene, and 3 died. Of the deaths all were in pre-antiseptic times, 1 was due to gangrene, 1 to secondary hemorrhage, and 1 to amputation on account of secondary hemorrhage. We shall return to the question of gangrene later. Two cases relapsed—Norris's, situated upon the brachial, and Davies-Colley's, upon the femoral in Scarpa's triangle. In the first case the relapse was due to an arterial branch given off from the sac, which fed it after the ligature was applied; and in the second it is supposed to have been due to the premature softening of the catgut ligature. The cause in Norris's case illustrates the strongest objection to the method, and among the cases of this disease examined by operation or post-mortem will be found many which have the same anatomical arrangement, making a cure by this method an impossibility; for instance, those of Brainard, Ollier, Venturoli, v. Wahl, and myself. As bearing upon this point we may also quote the case of Galozzi (Bramann, Case 127), who tied the external iliac without improvement, and some days later tied the femoral in Scarpa's triangle below the sac, also without effect—the number of branches given off in this location readily explains the bad result. We may also note Stimson's case (*AMERICAN JOURNAL OF THE MEDICAL SCIENCES*, 1884, lxxxvii. 325, and *N. Y. Med. Journ.*, 1888, i. 214, 555) of aneurismal varix between the common carotid near its bifurcation with the internal jugular vein, in which he tied the common carotid with temporary improvement, and four years later secured both the external and internal carotids beyond the point of communication between the artery and the vein without lasting result, the intermediate part of the artery evidently being fed by the superior thyroid, as pressure in the course of that vessel caused the thrill to cease.¹

Ligature of both vessels.—A greater security against relapse from this cause is obtained by ligature of both the artery and the vein close to

¹ Dr. Stimson tells me that the man is still alive, the aneurism unaltered.

the sac. It is not absolutely necessary to ligate the vessels peripherally, for central ligation of both vessels has produced a cure in two cases (Moore, Keen¹), although this practice is certainly not sufficiently reliable to be recommended for general adoption. In three cases the artery was ligated above and below, and the vein peripherally only, or centrally only, all being successful—unless we except Davies-Colley's (the second operation in this case), in which it was supposed that the catgut ligature softened prematurely, causing a partial relapse which necessitated a third operation in which the artery was ligated again below. In two cases both vessels were secured above and below. We have then 7 cases of ligation of both vessels, 6 cured, and 1 in which relapse took place from softening of the ligation on the artery. They include 3 at the flexure of the elbow, and 1 each of the temporal, femoral, popliteal, and tibial arteries.

We may note in passing that Monmonnier (Bramann, Case 93) cured an arterio-venous aneurism at the flexure of the elbow, of short duration, by obliterating the basilic vein above and below the point of communication, by passing pins beneath the vessel and making figure-of-eight turns of a ligation over them. Stromeyer claims to have cured a temporal arterio-venous aneurism by ligation of the vein alone beyond the point of communication, but he also ligated another vessel (which he thought to be a vein) which communicated with the varix and was accidentally wounded in the operation—moreover, the pulsation and thrill continued after the operation and the wound healed with long and tedious suppuration, so the cure may fairly be ascribed to the effect of this inflammation around the sac.

Incision and ligation.—The so-called ancient method of treating aneurisms by incision and ligation of the vessels, with which we may also include the cases in which the vessels were ligated before the sac was laid open, is a more satisfactory method than simple ligation, and it is also generally easier of execution. The cases of incision of the sac with ligation of the vessels number 17. Among these there were 5 deaths and 1 recovery after amputation of the limb, but all of these accidents occurred in pre-antiseptic times, and they were all due to sepsis or secondary hemorrhage; the fatal cases being thus distributed—1 brachial, 3 femoral, and 1 popliteal, and the amputation having occurred in a popliteal case. Of the 11 cured, 2 were temporal, 6 brachial, 2 popliteal, and 1 tibial. It should be noted that all but 4 of these 17 cases were operated upon prior to 1870.

Extirpation.—An equally reliable method is that of extirpation of the aneurismal sac, of which I have the records of 20 cases. There is only

¹ Dr. Keen informs me that his patient was free from any return when he last saw her, about two years after the operation.

one death in this series, which was due to sepsis, although it was operated upon by a capable surgeon in 1878, affording an illustration that accidents will sometimes occur in the course of wound-healing even in modern days. Relapses were impossible, consequently all of the remaining 19 cases have been cured. The cases are thus distributed: temporal 4, radial (fatal) 1, brachial 3, axillary 1, articular artery of the knee 1, anastomotica magna 1, femoral 6, and popliteal 3.

Results.—To gain a proper idea of these operations upon the sac, or upon the vessels near the point of communication, we must group them together, for the differences between them as to danger to life and limb may be considered about equal, since, although the extirpation of the sac may require more time than incision, this appears to have produced no effect upon the mortality, the only death in the 20 cases of extirpation having been due to sepsis, and not to the prolonged operation. Moreover, the accidental fact that most of the cases of extirpation were performed since 1870, while those of incision were performed before that date, gives the former almost no mortality, and the latter a death-rate of nearly 33 per cent. We have, then, a total of 60 cases treated by these various operations, with 47 cures, 2 relapses (both in operations upon the artery alone), 2 limbs lost by amputation, and 9 deaths. All but one of the cases in which life or limb was lost were operated upon before 1870, and in all but two sepsis was the cause of the accident. In these two gangrene occurred, and this brings us to a question which has been left until now for our study.

In 21 operations upon the brachial there was one case of gangrene, in 16 upon the femoral there was 1 case of gangrene, and also Billroth's fatal case of incision with ligature of both artery and vein, in which, on account of secondary hemorrhage, the artery had to be tied again above the origin of the profunda, and gangrene followed. On account of the known frequency of gangrene after ligature of the common femoral, we may regard this case as bearing only upon aneurisms so situated that a ligature of the common femoral would be necessary. The other case of gangrene from ligature of the femoral was Dupuytren's case of incision and ligature for a varicose aneurism in Hunter's canal, in which the arteries of the entire limb were degenerated, and in which the unnatural condition may have had something to do with the result. The case of gangrene after ligature of the brachial was a varicose aneurism of the flexure of the elbow operated upon by Roux with ligature of the artery alone above and below the sac, after continuous pressure and bandaging had been kept up during the three years of its existence, and Roux very plausibly refers the gangrene to a diminution of the blood-supply of the limb, owing to this treatment. In addition to these 37 cases, there are 9 operations upon the popliteal, and 1 upon the axillary artery without gangrene—a total of 46 operations upon the main artery and vein of a

limb with only 3 cases of gangrene, even including Billroth's, results which are so good that, bearing in mind the peculiar character of those 3 cases, we can safely say that in the ordinary arterio-venous aneurism (after a duration of one month) there is less danger of gangrene in securing both vessels near their point of communication than there is in applying the Hunterian ligature for true arterial aneurisms.

Conclusions.—We have seen that compression is only suitable for cases which are seen early, and in which the affected vessels lie superficially; and if it is not successful at once, or, if its employment is difficult or painful, the risks of operation are not sufficiently great to warrant delay. It is my conviction that all these cases should be treated by operation, with the single exception of the cases involving the internal jugular, or requiring ligature of the common femoral artery and vein. It does not appear necessary to distinguish between aneurismal varix and varicose aneurism as to treatment. The choice of methods depends upon the size and situation of the aneurism. In a general way, it may be said that all small aneurisms not involving the larger vessels of a limb should be extirpated unless important nerves are jeopardized by the dissection, or, as on the face, it is important not to leave a scar. The treatment selected for larger aneurisms depends upon their situation. Those of the neck which involve the external jugular vein will rarely require treatment, but should it be necessary, such cases are best treated by double ligation of both vessels. In other situations the simple ligature of the vessels should not be chosen, for it will, in most cases, require as much dissection as will incision or extirpation, while not giving the same immunity from relapse. The surgeon should make an incision down upon the sac in its entire length, and attempt to dissect it from its bed. If this prove difficult or impossible because of inflammatory thickening or intimate connection with important parts, the sac should be incised, for it is often easier to secure the vessels when the sac is freely opened. The sac could then be left entirely in place, or it could be partly removed, and it may be as well to say that suture and simple drainage of the sac have been found sufficient, and that it is unnecessary to resort to packing. In closing, we must not forget that the recently-introduced suture of veins, and the successful experimental suture of arteries, may alter our methods of treatment in some of these cases—in fact, Bassini (*Riforma med.*, 1890, April 15, 16) has already cured a case by double ligature of the artery and suture of the opening in the vein.

LITERATURE OF CASES.

To economize space I quote only the numbers of cases in Bramann's list which are correctly referred to by him, but I have verified his cases in the originals, except Cases 55 and 148, which were not accessible. I have included in my list only cases of four weeks' standing or more, for those of shorter duration are more correctly studied as wounds of artery and vein than as aneurisms.

Double Ligature of Artery.

- Dupuytren* : Breschet, Mém. Acad. roy. méd., Paris, 1833, iii. 226.
Norris : AMER. JOURN. OF MED. SCIENCES, 1843, v. 28. (First operation.)
Roux : Quarante Années de prat. chir., Paris, 1855, ii., Cases XXXVI. to XXXIX., pp. 286 to 295.
Malgaigne : Bull. Soc. anat., Paris, 1858, xxxiii. 355.
Hamilton : Holmes, Lancet, 1874, ii. 543.
Blomfield : Lancet, 1881, ii. 829.
Davies-Colley : Guy's Hospital Rep., 1888, xiv. 348. (First operation.)
Championnière : Bull. Soc. chir., 1888, Paris, xiv. 39.
Branham : Internat. Journ. of Surgery, New York, Nov., 1890, p. 250.
Bramann : Arch. f. klin. Chir., 1886, xxxiii. 1. Cases 55, 66, and 117.

Ligature of Both Vessels.

- Moore* : Med.-Chir. Trans., xli. 1; and Brit. Med. Journ., 1857, 972.
Keen : Med. News, Phila., 1887, ii. (vol. li.) 725.
Roux : Loc. cit., Case XXXV. p. 271.
Davies-Colley : Loc. cit. (Second and third operations.)
Bramann : Loc. cit., Cases 89, 148, and 155.

Incision.

- Breschet* : Loc. cit., p. 219.
Bérard : Compend. chir. prat., ii. 127; and Arch. gén. méd., 1845, sér. iv. T. vii. p. 38.
Norris : Loc. cit. (Second operation.)
Brainard : Illinois and Indiana Med. and Surg. Journ., 1848. N. S. ii. 505.
Roux : Loc. cit., Case XL. p. 299.
Richet : Bull. Soc. chir., Paris, 1862, 281; and Gaz. des hôp., 1861, p. 215.
Nélaton : France méd., 1863, 197.
Nélaton : Reclus, Bull. Soc. chir., Paris, 1863, 285.
Billroth : Chir. Klinik. Wien., 1868, 158.
Verneuil : Reclus, loc. cit., p. 280.
Bramann : Loc. cit., Cases 46, 109, 3, 74, 8, 149, 156.

Extirpation.

- Ollier* : Mém. Soc. méd. Lyon, 1865, iv. Part 2, 159; and Reclus, loc. cit.
Brach : Boston Med. and Surg. Journ., 1867, lxxvii. 361.
Thorndike : Boston Med. and Surg. Journ., 1878, xcix. 475.
Robinson : Brit. Med. Journ., 1887, ii. 885; and Path. Trans., London, 1888, xxxix. 85.
Trélat : Delbet, Bull. Soc. chir., Paris, 1889, xv. 153, 491.
Menocal : Rev. de Cien. Med., Habana, iv., 1889, 161.
Graziani : Riforma Med. Napoli, Jan. 7-10, 1890.
Simons : Trans. South Carolina Med. Assoc., Charleston, 1890, p. 125.
Weir : Curtis, this paper.
Bramann : Loc. cit., Cases 49, 2, 7, 154, 122, 137, 10, 139, and 159.

THE AMERICAN JOURNAL OF THE MEDICAL SCIENCES.

MONTHLY, \$4.00 PER ANNUM.

WITH 1891 THE AMERICAN JOURNAL OF THE MEDICAL SCIENCES enters upon its seventy-second year, still the leader of American medical magazines. In its long career it has developed to perfection the features of usefulness in its department of literature, and presents them in unrivalled attractiveness. It is the medium chosen by the leading minds of the profession on both sides of the Atlantic for the presentation of elaborate Original Articles; its Reviews are noted for discernment and absolute candor, and its Classified Summaries of Progress present, each month, an epitome of medical advances gleaned by specialists in the various departments. According to unquestionable authority, "It contains many original papers of the highest value; nearly all the real criticisms and reviews which we possess; and such carefully prepared summaries of the progress of medical science and notices of foreign works, that from this file alone, were all other publications of the press for the last fifty years destroyed, it would be possible to reproduce the great majority of the real contributions of the world to medical science during that period."

THE MEDICAL NEWS.

WEEKLY, \$4.00 PER ANNUM.

Marked and successful changes have been made during 1890, resulting from a careful study of the needs of the profession. The same effort will be made unceasingly to render THE NEWS of the greatest possible assistance to each practitioner. Leading writers, teachers and practitioners will furnish original articles, clinical lectures and brief, practical notes; hospital physicians and surgeons will detail the latest approved methods developed under their enormous opportunities; progress is gleaned from the best journals of all civilized nations; able editorial writers will deal with important questions of the day; current literature will be impartially reviewed; society proceedings will be represented by the pith alone; correspondence will continue to be received from medical men in position to know all occurrences of medical importance in the districts surrounding important medical centres, and matters of interest will be grouped under news items. THE NEWS, in short, is a crisp medical newspaper, a necessity to every practitioner. Its sphere is different from and complementary to that of the ideal medical magazine, THE AMERICAN JOURNAL. To lead every reader of either to prove for himself the value of the two combined, the commutation rate has been fixed at the rate of \$7.50 per annum.

The Year-Book of Treatment for 1890

Gives a classified summary and review of the real advances in treatment made during 1889, in all departments of the science of medicine. Price, \$1.25; or in combination with either or both the above journals, 75 cents. *Now ready.*

The Medical News Visiting List for 1891

Will be published in four styles: Weekly, dated, for 30 patients; Monthly, undated, for 120 patients per month; Perpetual, undated, for 30 patients weekly per year; Perpetual, for 60 patients weekly per year. The first three styles contain 32 pages of important data and 176 pages of assorted blanks; the 60-patient perpetual consists of 256 pages of blanks. Price, each, \$1.25. In combination with either or both above periodicals, 75 cents. Or, JOURNAL, NEWS, VISITING LIST and YEAR-BOOK, \$8.50. Thumb-letter index for VISITING LIST, 25 cents extra.

LEA BROTHERS & CO., PUBLISHERS, PHILADELPHIA, 706 & 708 Sansom Street.